

FORM PTO-1390 (REV 11-2000)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER 117-363
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.5) 09/914184 <small>Unknown</small>
INTERNATIONAL APPLICATION NO. PCT/US00/04699	INTERNATIONAL FILING DATE 25 February 2000	PRIORITY DATE CLAIMED 26 February 1999
TITLE OF INVENTION SYNERGISTIC COMBINATION FOR TREATMENT OF VIRAL-MEDIATED DISEASES		
APPLICANT(S) FOR DO/EO/US TAN et al.		
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:		
1. <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371. 2. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371. 3. <input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below. 4. <input checked="" type="checkbox"/> The U.S. has been elected by the expiration of 19 months from the priority date (Article 31). 5. A copy of the International Application as filed (35 U.S.C. 371(c)(2)). a. <input type="checkbox"/> is attached hereto (required only if not communicated by the International Bureau). b. <input checked="" type="checkbox"/> has been communicated by the International Bureau. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US). 6. <input type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)). a. <input type="checkbox"/> is attached hereto. b. <input type="checkbox"/> has been previously submitted under 35 U.S.C. 154(d)(4). 7. <input type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)). a. <input type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau). b. <input type="checkbox"/> have been communicated by the International Bureau. c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired. d. <input type="checkbox"/> have not been made and will not be made. 8. <input type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)). 9. <input type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). 10. <input type="checkbox"/> A English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)). Items 11 To 20 below concern document(s) or information included: 11. <input type="checkbox"/> An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98. 12. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included. 13. <input checked="" type="checkbox"/> A FIRST preliminary amendment. 14. <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment. 15. <input type="checkbox"/> A substitute specification. 16. <input type="checkbox"/> A change of power of attorney and/or address letter. 17. <input type="checkbox"/> A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821-1.825. 18. <input type="checkbox"/> A second copy of the published international application under 35 U.S.C. 154(d)(4). 19. <input type="checkbox"/> A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4). 20. <input checked="" type="checkbox"/> Other items or information. PTO-1449/ International Search Report		

U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.51) 09/14184 INTERNATIONAL APPLICATION NO. PCT/US00/04699	ATTORNEY'S DOCKET NUMBER 117-363	
21. <input checked="" type="checkbox"/> The following fees are submitted:		CALCULATIONS PTO USE ONLY
BASIC NATIONAL FEE (37 C.F.R. 1.492(a)(1)-(5): -- Neither international preliminary examination fee (37 C.F.R. 1.482) nor international search fee (37 C.F.R. 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO\$1000.00 -- International preliminary examination fee (37 C.F.R. 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO.....\$860.00 -- International preliminary examination fee (37 C.F.R. 1.482) not paid to USPTO but international search fee (37 C.F.R. 1.445(a)(2)) paid to USPTO\$710.00 -- International preliminary examination fee (37 C.F.R. 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4)\$690.00 -- International preliminary examination fee (37 C.F.R. 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4)\$100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =		\$ 860.00
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input checked="" type="checkbox"/> 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e)).		\$ 130.00
CLAIMS	NUMBER FILED	NUMBER EXTRA
Total Claims	18	-20 = 0
Independent Claims	4	-3 = 1
MULTIPLE DEPENDENT CLAIMS(S) (if applicable)		\$270.00
TOTAL OF ABOVE CALCULATIONS =		\$ 1070.00
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.		0.00
SUBTOTAL =		\$ 1070.00
Processing fee of \$130.00, for furnishing the English Translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 C.F.R. 1.492(f)).		0.00
TOTAL NATIONAL FEE =		\$ 1070.00
Fee for recording the enclosed assignment (37 C.F.R. 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28, 3.31). \$40.00 per property		0.00
Fee for Petition to Revive Unintentionally Abandoned Application (\$1240.00 - Small Entity = \$620.00)		0.00
TOTAL FEES ENCLOSED =		\$ 1070.00
		Amount to be:
		refunded \$
		Charged \$
a. <input checked="" type="checkbox"/> A check in the amount of \$1070.00 to cover the above fees is enclosed. b. <input type="checkbox"/> Please charge my Deposit Account No. 14-1140 in the amount of \$_____ to cover the above fees. A duplicate copy of this form is enclosed. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <u>14-1140</u> . A <u>duplicate</u> copy of this form is enclosed. d. <input checked="" type="checkbox"/> The entire content of the foreign application(s), referred to in this application is/are hereby incorporated by reference in this application.		
NOTE: Where an appropriate time limit under 37 C.F.R. 1.494 or 1.495 has not been met, a petition to revive (37 C.F.R. 1.137(a) or (b)) must be filed and granted to restore the application to pending status.		
SEND ALL CORRESPONDENCE TO: NIXON & VANDERHYE P.C. 1100 North Glebe Road, 8 th Floor Arlington, Virginia 22201-4714 Telephone: (703) 816-4000		
SIGNATURE <u>Mary J. Wilson</u>		
NAME Mary J. Wilson		
REGISTRATION NUMBER 32,955		Date August 23, 2001

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09/914184

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of

TAN et al.

Atty. Ref.: 117-363

Serial No. Unknown

Group:

Filed: August 23, 2001

Examiner:

For: SYNERGISTIC COMBINATION FOR TREATMENT OF VIRAL-MEDIATED
DISEASES

* * * * *

August 23, 2001

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

PRELIMINARY AMENDMENT

In order to place the above-identified application in better condition for examination,
please amend the application as follows:

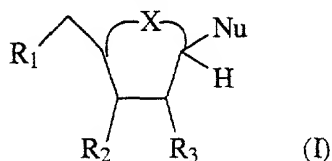
IN THE CLAIMS

Please cancel claims 1-21 without prejudice or disclaimer.

Please add new claims 22-39 as follows.

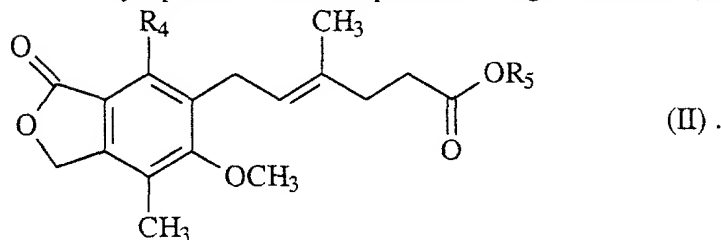
22. A method of treating a host having a flavivirus or rhabdovirus infection, which method comprises administering to the host effective amounts of:

- (a) an interferon, and
- (b) at least one compound selected from the group consisting of:
 - 5-membered cyclic nucleosides having the formula (I):



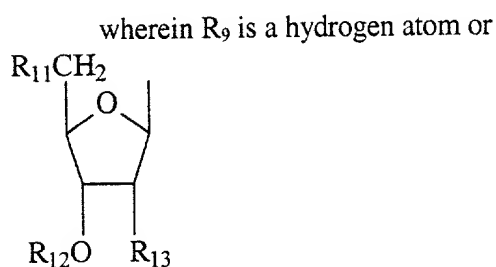
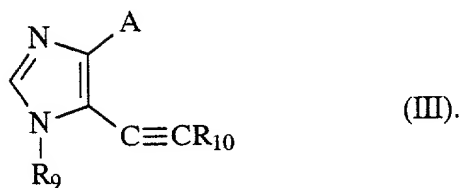
wherein *X* is $\equiv\text{CH}$ -, $-\text{CH}_2$ - or $-\text{O}$ -, Nu is selected from the group consisting of purines, pyrimidines and five- or six-membered aglycones, R_2 and R_3 are independently selected from the group consisting of H, OH, C-acyl, O-aryl and O-silyl, and R_1 is as defined for R_2 and R_3 or is O-phosphate, and pharmaceutically acceptable metabolites, metabolite derivatives and salts thereof;

- mycophenolic acid compounds having the formula (II)



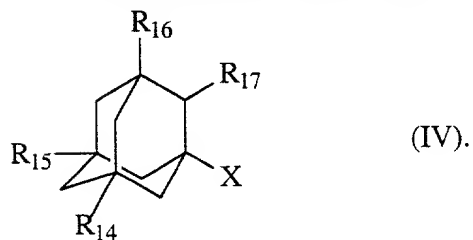
wherein R_4 is $-\text{OR}_6$ or $-\text{N}(\text{R}_7)$ R_8 in which R_6 , R_7 and R_8 are independently selected from the group consisting of hydrogen and C_1 - C_6 alkyl, and R_5 is selected from the group consisting of hydrogen, phenyl and C_1 - C_6 alkyl

- unsubstituted or substituted by a five- or six-membered saturated or unsaturated heterocyclic ring, and pharmaceutically acceptable salts thereof;
- imidazole derivatives represented by formula (III):



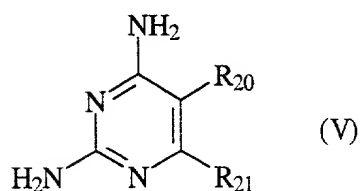
wherein R₁₀ is a hydrogen atom, C₁-C₆ alkyl, hydroxy(C₁-C₆ alkyl) or phenyl, R₁₁ and R₁₃ are independently selected from hydrogen and OR₁₂ and R₁₂ is a hydrogen atom or a hydroxy protecting group and A is CONH₂ or CN, and pharmaceutically acceptable salts thereof;

- aminoadamantanes having the formula (IV):



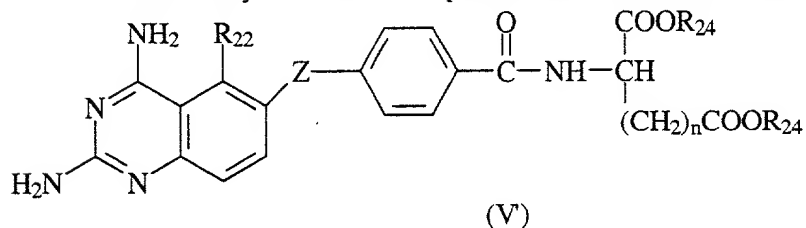
wherein each of R_{14} , R_{15} , R_{16} and R_{17} is independently selected from the group consisting of H, F and CH_3 and X is $N(R_{18})_2$, $CH_2CH_2N(R_{18})_2$ or $C(R_{19})_2N(R_{18})_2$ wherein each R_{18} and R_{19} is H, (C_1-C_6) alkyl, (C_6-C_{10}) aryl and (C_7-C_{18}) aralkyl; and

- 2,4-diaminopyrimidines having the formula (V):



wherein R_{20}

is phenyl substituted by one or more substituents selected from the group consisting of benzyl, NO_2 , (C_1-C_6) alkylamino and halogen and R_{21} is H or C_1-C_6 alkyl; or R_{20} and R_{21} form, together with the 2,4-diaminopyrimidine ring to which they are attached, a quinazoline derivative of formula (V'):



wherein Z is $-CH_2NR_{23}-$ or $-NR_{23}CH_2-$; R_{22} , R_{23} and R_{24} are each, independently, H or C_1-C_6 alkyl; and n is 1 or 2, and pharmaceutically acceptable salts thereof.

23. A method according to claim 22, wherein the flavivirus is selected from yellow fever virus, kunjin virus, dengue virus, hepatitis C virus, St. Louis encephalitis virus, Japanese encephalitis virus, Murray valley encephalitis virus and tick-borne encephalitis virus.

24. A method according to claim 22, wherein the rhabdovirus is selected from vesicular stomatitis virus (VSV) and rabies virus.

25. A method according to claim 22, wherein the interferon (a) is a human interferon.

26. A method according to claim 22, wherein the interferon is selected from interferon $\alpha 2$, interferon $\alpha 8$ and interferon β .

27. A method according to claim 26, wherein the interferon is human interferon $\alpha 8$ having a specific activity of from 0.6×10^9 to 1.5×10^9 IU per mg protein.

28. A method according to claim 26, wherein the interferon is human interferon β having a specific activity of from 4×10^8 to 8×10^8 per mg protein.

29. A method according to claim 22, wherein the compound (b) is at least one compound selected from cyclopentenyl cytosine, mycophenolic acid, 5-ethynyl-1- β -D-ribofuranosylimidazole-4-carboxamide, amantadine hydrochloride, 3-deazaneplanocin, neplanocin A, 3-deazauridine, 6-azauridine, aristeromycin, pyrazofurin, tiazaforin, selenofurin, NSC 382046, NSC 7364, NSC 302325, NSC 184692D and NSC 382034.

30. Products containing an interferon and at least one compound (b) as defined in claim 22 as a combined preparation for simultaneous, separate or sequential use in treating a flavivirus or rhabdovirus infection.

31. A method of treating a host having a flavivirus or rhabdovirus infection, which method comprises administering an effective amount of an interferon $\alpha 8$ having a specific activity of from 0.6×10^9 to 1.5×10^9 IU per mg protein.

32. A method according to claim 31, wherein the flavivirus is selected from yellow fever virus, kunjin virus, dengue virus, hepatitis C virus, St. Louis encephalitis virus, Japanese encephalitis virus, Murray valley encephalitis virus and tick-borne encephalitis virus.

33. A method according to claim 31, wherein the rhabdovirus is VSV.

34. A method according to claim 31, wherein the interferon $\alpha 8$ is human interferon $\alpha 8$.

35. Interferon $\alpha 8$ having a specific activity of from 0.6×10^9 to 1.5×10^9 IU per mg of protein for use in a method of treatment of the human or animal body by therapy.

36. Interferon $\alpha 8$ according to claim 35, for use in the treatment of a flavivirus or rhabdovirus infection.

37. An anti-flavivirus or anti-rhabdovirus agent comprising interferon $\alpha 8$ having a specific activity of from 0.6×10^9 to 1.5×10^9 IU per mg of protein.

38. A method of treating a host having a flavivirus or rhabdovirus infection, which method comprises the step of administering to the host, in respective amounts which produce a synergistic ant Flavivirus or antirhabdovirus effect, an interferon and at least one compound (b) as defined in claim 22.

39. An agent for use in the treatment of a flavivirus or rhabdovirus infection, which comprises an interferon and at least one compound (b) as defined in claim 22.

TAN et al.
Serial No. **Unknown**

REMARKS

The above amendments are made to place the claims in a more traditional format.

Respectfully submitted,

NIXON & VANDERHYE P.C.

By: Mary J. Wilson
Mary J. Wilson
Reg. No. 32,955

MJW:ms
1100 North Glebe Road, 8th Floor
Arlington, VA 22201-4714
Telephone: (703) 816-4000
Facsimile: (703) 816-4100

SYNERGISTIC COMBINATION FOR TREATMENT OF
VIRAL-MEDIATED DISEASES

Field of the Invention

- 5 This invention relates to the use of interferons as antiviral agents.

Background to the Invention

Human interferons (IFN) were originally prepared from human white blood cells, a by-product of blood banks, and from primary human fibroblasts in culture.

- 10 The white cell product was called human leukocyte interferon or human alpha interferon and the human fibroblast interferon was called human β interferon. Subsequent to the cloning of interferons in *E. coli*, several subtypes of human interferons have been identified. There are at least 15 subtypes of alpha interferon (Henco K. *et al.*, J. Mol Biol. 185, 227-260, 1985) and only one β interferon.
- 15 Cyclopentenyl cytosine (CPE-C) was a promising anti-tumor compound in clinical trial until two deaths were observed in the trial. Four of the eleven patients who received 4.7 mg/m² per hour of CPE-C experienced hypotension 24 to 48 hours after completion of the CPE-C infusion during their first, third and sixth cycles respectively. Two of the four hypotensive patients died with refractory hypotension.
- 20 The trial was immediately stopped by the National Cancer Institute, USA. Hypotension was not seen in patients receiving ≤ 2.5 mg/m² per h CPE-C (Cancer Chemother. Pharmacol. 36, 513-523, 1995). The mean CPE-C steady-state plasma levels (Cpss) increased linearly from 0.4 μ M to 3.1 μ M at doses ranging from 1 to 5.9 mg/m²/h.
- 25 Mycophenolic acid was first demonstrated by H. Florey in 1946 to inhibit bacteria, fungi and leukocytes. The prodrug mycophenolate mofetil is now an FDA-approved transplantation drug.

Summary of the Invention

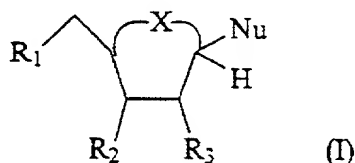
- 30 We have now found that an interferon such as interferon $\alpha 2$, interferon $\alpha 8$ or interferon β can act synergistically with particular compounds to combat flavivirus

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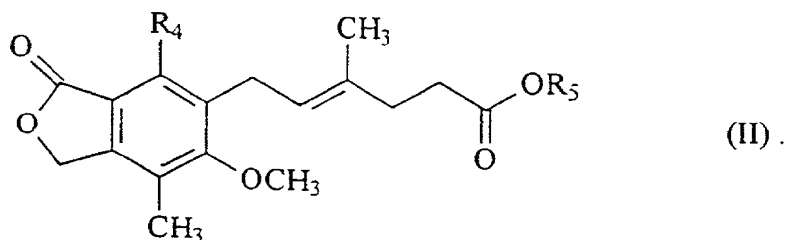
and rhabdovirus infections. This synergistic antiviral effect means that lower concentrations of the small molecular weight chemicals such as CPE-C can be used together with interferons as antirhabdoviral and antirhabdoviral agents and at concentrations below its anticipated side effects (hypotension) in man (1.0 μ M or less).

Accordingly, the present invention provides a method of treating a host having a flavivirus or rhabdovirus infection, which method comprises the step of administering to the host in respective amounts which produce a synergistic antirhabdoviral or synergistic antirhabdoviral effect:

- 10 (a) an interferon, and
- (b) at least one compound selected from the group consisting of:
 - 5-membered cyclic nucleosides having the formula (I):



- 20 wherein $\sim X \sim$ is $=CH-$, $-CH_2-$ or $-O-$, Nu is selected from the group consisting of purines, pyrimidines and five- or six-membered aglycones, R_2 and R_3 are independently selected from the group consisting of H, OH, O-acyl, O-aryl and O-silyl, and R_1 is as defined for R_2 and R_3 or is O-phosphate, and pharmaceutically acceptable metabolites, metabolite derivatives and salts thereof;
- 25 - mycophenolic acid compounds having the formula (II)

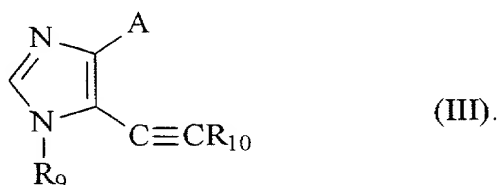


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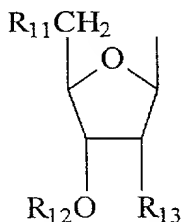
wherein R_4 is $-OR_6$ or $-N(R_7)R_8$ in which R_6 , R_7 and R_8 are independently selected from the group consisting of hydrogen and C_1 - C_6 alkyl, and R_5 is selected from the group consisting of hydrogen, phenyl and C_1 - C_6 alkyl unsubstituted or substituted by a five- or six-membered saturated or unsaturated heterocyclic ring, and

5 pharmaceutically acceptable salts thereof;

- imidazole derivatives represented by formula (III):

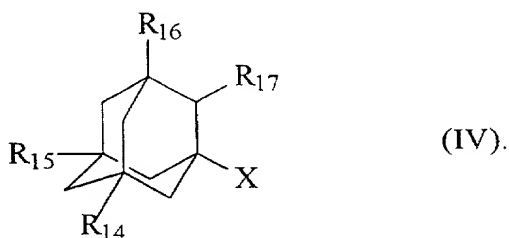


wherein R_9 is a hydrogen atom or



wherein R_{10} is a hydrogen atom, C_1 - C_6 alkyl, hydroxy(C_1 - C_6 alkyl) or phenyl, R_{11} and R_{13} are independently selected from hydrogen and OR_{12} , R_{12} is a hydrogen atom or a hydroxy protecting group and A is $CONH_2$ or CN, and pharmaceutically acceptable salts thereof;

- aminoadamantanes having the formula (IV):



wherein each of R_{14} , R_{15} , R_{16} and R_{17} is independently selected from the group consisting of H, F and CH_3 and X is $N(R_{18})_2$, $CH_2CH_2N(R_{18})_2$ or $C(R_{19})_2N(R_{18})_2$ wherein each R_{18} and R_{19} is H, (C_1 - C_6) alkyl, (C_6 - C_{10}) aryl and

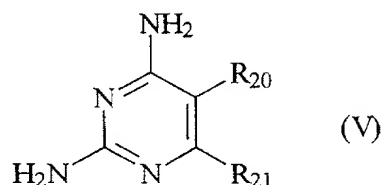
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(C₇-C₁₈) aralkyl; and

- 2,4-diaminopyrimidines having the formula (V):

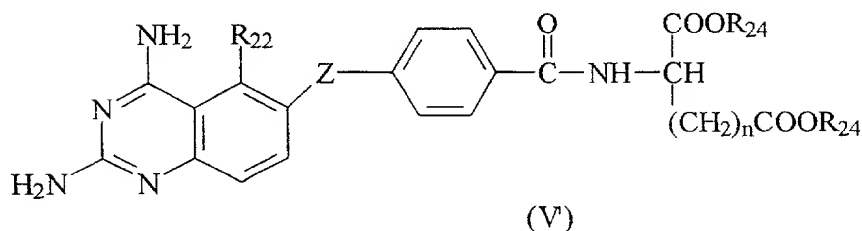
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10

wherein R₂₀ is phenyl substituted by one or more substituents selected from the group consisting of aralkyl, NO₂, (C₁-C₆) alkylamino and halogen and R₂₁ is H or C₁-C₆ alkyl; or R₂₀ and R₂₁ form, together with the 2,4-diaminopyrimidine ring to which they are attached, a quinazoline derivative of formula (V'):

15



20

wherein Z is -CH₂NR₂₃- or -NR₂₃CH₂-; R₂₂, R₂₃ and R₂₄ are each, independently, H or C₁-C₆ alkyl; and n is 1 or 2, and pharmaceutically acceptable salts thereof.

In formula (V) the aralkyl substituent is an aryl group linked via an alkylene chain of 1 to 6 carbon atoms. Aryl is typically phenyl or naphthyl. Preferred examples of aralkyl are benzyl and phenethyl. In formula (V') R₂₂ is preferably methyl or ethyl, especially ethyl, R₂₃ and R₂₄ are preferably H and n is preferably 1.

The present invention encompasses all optical isomers of the compound (b), in particular the D- and L-isomers of the nucleosides of formula (I) and of the quinazoline derivatives of formula (V').

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rhabdovirus infections also forms part of the invention. The invention therefore further provides a method of treating a host having a flavivirus or rhabdovirus infection, which method comprises the step of administering to the host a therapeutically effective amount of an interferon $\alpha 8$ having a specific activity of from 5 0.3×10^9 to 3×10^9 IU per mg protein.

The invention additionally provides:

- use of an interferon in the manufacture of a medicament for use with at least one compound (b) as defined above in the treatment of a flavivirus or rhabdovirus infection;
- 10 - use of at least one compound (b) as defined above in the manufacture of a medicament for use with an interferon in the treatment of a flavivirus or rhabdovirus infection;
- products containing an interferon and at least one compound (b) as defined above as a combined preparation for simultaneous, separate or sequential use in treating a flavivirus or rhabdovirus infection;
- 15 - interferon $\alpha 8$ having a specific activity of from 0.3×10^9 to 3×10^9 IU per mg of protein for use in a method of treatment of the human or animal body by therapy;
- use of interferon $\alpha 8$ having a specific activity of from 0.3×10^9 to 3×10^9 IU per 20 mg of protein in the manufacture of a medicament for use in the treatment of a flavivirus or rhabdovirus infection; and
- an anti-flavivirus or anti-rhabdovirus agent comprising interferon $\alpha 8$ having a specific activity of from 0.3×10^9 to 3×10^9 IU per mg of protein.

25 **Detailed Description of the Invention**

Interferons

The interferon for use in the present invention may be an interferon α , such as interferon $\alpha 2$ or $\alpha 8$, or interferon β . The term "interferon" includes fragments which have interferon activity and mutant forms of an interferon which retain interferon 30 activity. For example, the sequence of an interferon α or β may have been modified to enhance activity or stability as reported in US-A-5582824, US-A-5593667 or US-

A-5594107.

The interferon may have been purified from natural sources or may be a recombinant interferon. The species of interferon is generally the same as the host species to which the interferon is administered. The invention is particularly

- 5 applicable to the treatment of flavivirus infections in humans. Preferably therefore a human interferon such as human interferon $\alpha 2$ or $\alpha 8$ or human interferon β is used.

The interferon $\alpha 8$, particularly the human interferon $\alpha 8$, typically has a specific activity of more than 0.6×10^9 , generally from 0.6×10^9 to 1.5×10^9 and preferably from 0.8×10^9 to 1.5×10^9 , IU per mg protein. The human interferon β

10 typically has a specific activity of from 4×10^8 to 8×10^8 , preferably from 4.8×10^8 to 6.4×10^8 , IU per mg protein. Interferon α and interferon β specific activities are determined according to reference standards Gb-23-902-530 and Gb-23-902-531 respectively. Specific activity is determined according to a modification of the method of Armstrong, Applied Microbiology 21, 723, 1971, in which $0.2 \mu\text{g/ml}$ of

15 actinomycin D is included in the viral challenge and the viral induced cytopathic effect (CPE) is read directly from the primary human fibroblasts. Alternatively, specific activity is determined according to the method of Armstrong using WISH cells as assay cells and Encephalomyocarditis virus as challenge virus and the viral induced CPE is read directly.

20 The interferon such as the interferon $\alpha 2$ or $\alpha 8$ or the interferon β is preferably obtainable by the methodology of WO 96/30531. The interferon is thus obtainable by a process comprising culturing mammalian cells transfected with a nucleic acid vector comprising:

- (i) a coding sequence which encodes the interferon and which is operably linked
- 25 to a promoter capable of directing expression of the coding sequence in mammalian cells in the presence of a heavy metal ion;
- (ii) a first selectable marker sequence which comprises a metallothionein gene and which is operably linked to a promoter capable of directing expression of the metallothionein gene in the cells in the presence of a heavy metal ion; and
- 30 (iii) a second selectable marker sequence which comprises a *neo* gene and which is operably linked to a promoter capable of directing expression of the *neo*

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gene in the cells;
unless conditions that allow expression of the coding sequence; and recovering the
interferon thus produced.

The transfected mammalian cells may be cells of a human or animal cell line.

- 5 They may be BHK, COS, CHO Lec2, L CL3, Vero, human fibroblastoid such as
C1O, HeLa, or human lymphoblastoid cells or cells of a human tumour cell line.
Preferably, however, the cells are CHO cells, particularly wild-type CHO cells.

Desirably, transfected cells will have all or part of such a vector integrated
into their genomes. Such cells are preferred because they give stable expression of
10 the coding sequence contained in the vector. Preferably, one or more copies of the
entire vector will be integrated, with cells having multiple integrated copies of the
vector, for example from 20 to 100 copies or more, being particularly preferred
because these cells give a high stable level of expression of the coding sequence
contained in the vector.

- 15 However, cells having less than complete sections of the vectors integrated
into their genomes can be employed if they are functionally equivalent to cells
having the entire vector integrated into their genomes, in the sense that the integrated
sections of the vector enable the cell to express the coding sequence and to be
selected for by the use of heavy metals. Thus, cells exhibiting partial integration of a
20 vector may be employed if the integrated element or elements include the coding
sequence operably linked to its associated promoter and the metallothionein marker
sequence operably linked to its associated promoter.

- Any promoter capable of enhancing expression in a mammalian cell in the
presence of a heavy metal ion such as Cd^{2+} , Cu^{2+} and Zn^{2+} may be operably linked to
25 the interferon coding sequence. A suitable promoter is a metallothionein gene
promoter. The mouse metallothionein gene I (mMT1) promoter is preferred.

- Suitable promoter/enhancer combinations for the coding sequence include the
mMT1 promoter flanked upstream with a mouse sarcoma virus (MSV) enhancer
(MSV-mMT1) and a Rous sarcoma virus (RSV) enhancer upstream of a mouse
30 mammary tumour virus (MMTV) promoter. MSV-mMT1 is preferred.

As far as the first selectable marker sequence is concerned, any promoter

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capable of enhancing expression in a mammalian cell in the presence of a heavy metal ion such as Cd^{2+} , Cu^{2+} and Zn^{2+} may be operably linked to the metallothionein gene such as a human metallothionein gene. Preferably, the marker sequence gene is a human metallothionein gene, such as the human metallothionein gene IIA, which

5 has its own promoter.

The second selectable marker sequence is a *neo* gene. More than one type of this gene exists in nature: any specific *neo* gene can be used in a vector of the invention. One preferred *neo* gene is the *E.coli neo* gene.

The promoter for the *neo* gene is capable of directing expression of the gene

10 in a mammalian cell. Suitable promoters are the cytomegalovirus (CMV) early promoter, the SV40 promoter, the mouse mammary tumour virus promoter, the human elongation factor 1 α -P promoter (EF-1 α -P), the SR α promoter and a metallothionein gene promoter such as mMT1. The promoter may also be capable of expressing the *neo* gene in bacteria such as *E.coli* in which a vector may be

15 constructed.

The interferon coding sequence (i) and the marker sequences (ii) and (iii) are thus each operably linked to a promoter capable of directing expression of the relevant sequence. The term "operably linked" refers to a juxtaposition wherein the promoter and the coding/marker sequence are in a relationship permitting the

20 coding/marker sequence to be expressed under the control of the promoter. Thus, there may be elements such as 5' non-coding sequence between the promoter and coding/marker sequence. Such sequences can be included in the construct if they enhance or do not impair the correct control of the coding/marker sequence by the promoter.

25 The vector may be a DNA or RNA vector, preferably a DNA vector. Typically, the vector is a plasmid. Each of the sequences (i) to (iii) will typically be associated with other elements that control their expression. In relation to each sequence, the following elements are generally present, usually in a 5' to 3' arrangement: a promoter for directing expression of the sequence and optionally a

30 regulator of the promoter, a translational start codon, the coding/marker sequence, a polyadenylation signal and a transcriptional terminator.

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Further, the vector typically comprises one or more origins of replication, for example a bacterial origin of replication, such as the pBR322 origin, that allows replication in bacterial cells. Alternatively or additionally, one or more eukaryotic origins of replication may be included in the vector so that replication is possible in, for example yeast cells and/or mammalian cells.

The vector may also comprise one or more introns or other non-coding sequences 3' or 5' to the coding sequence or to one or more of the marker sequences. Such non-coding sequences may be derived from any organism, or may be synthetic in nature. Thus, they may have any sequence. Such sequences may be included if they enhance or do not impair correct expression of the coding sequence or marker sequences.

The transfected cells are typically cultured in the presence of a heavy metal ion selected from Cd^{2+} , Cu^{2+} and Zn^{2+} , particularly in an amount which is not toxic to the cells. That can lead to higher expression of the desired interferon. The concentration of the heavy metal ion in the culture medium is typically from 100 to 200 μM . Cells may therefore be cultured in the presence of from 100 to 200 μM of a heavy metal ion selected from Cd^{2+} , Cu^{2+} and Zn^{2+} , for example from 130 to 170 μM of the heavy metal ion. A useful concentration is about 150 μM , particularly when the heavy metal ion is Zn^{2+} .

The interferon that is produced may be recovered by any suitable means and the method of recovery may vary depending on, for example, the type of cells employed and the culture conditions that have been used. Desirably, the interferon produced will be purified after recovery. Substantially pure interferon can thus be obtained.

The human β -interferon provided by WO 96/30531 has a high degree of sialylation. Like natural human β -interferon produced by primary diploid human fibroblasts, it is well glycosylated. However, it has a higher bioavailability than the natural β -interferon or recombinant β -interferon produced in *E.coli* (betaseron).

The higher bioavailability of the β -interferon can be characterised. When 1.5×10^6 IU of the interferon is injected subcutaneously into the back of a rabbit of about 2 kg: (a) ≥ 128 IU/ml of the interferon is detectable in the serum of the rabbit after 1

-10-

hour, and/or (b) ≥ 64 IU/ml of the interferon is detectable in the serum of the rabbit after 5 hours.

The maximum level of interferon is typically observed after 1 hour.

According to (a), therefore, 128 to 256 IU/ml such as 140 to 190 IU/ml of the
5 interferon may be detectable in the rabbit serum after 1 hour. After 5 hours according to (b), ≥ 70 IU/ml such as ≥ 80 IU/ml of the interferon may be detectable in the rabbit serum. Typically according to (b), an amount of interferon in the range of 64 to 128 IU/ml such as 80 to 110 IU/ml can be detected.

Additionally or alternatively, the human interferon β can be characterised by
10 its specific activity. It can have a specific activity from 4.8×10^8 to 6.4×10^8 IU per mg equivalent of bovine serum albumin protein, as noted above. The specific activity may be from 5×10^8 to 6×10^8 , for example from 5.2×10^8 to 5.8×10^8 such as from 5.3×10^8 to 5.5×10^8 , IU per mg equivalent of bovine serum albumin protein.

15 The human interferon β may also be characterised by one or more of the following properties:

1. The interferon β typically has an apparent molecular weight of 26,300 as determined by 15% sodium dodecyl sulphate-polyacrylamide gel electrophoresis (SDS-PAGE).
- 20 2. When injected as a neat intravenous bolus into a rabbit, the half life of the interferon is typically in the range of from 12 to 15 min such as about $13\frac{1}{2}$ min. The bolus is injected into the rabbit ear vein and blood samples are withdrawn from the rabbit ear artery. Rabbit serum is assayed for the antiviral activity of the interferon according to the modification of the method
25 of Armstrong (1971).
3. The antiviral activity of the interferon in a human hepatoblastoma cell line (HepG2) is at least equal to and, typically, about 1.5 times the activity of natural interferon β from primary diploid human fibroblast cells. The interferon is also about 2.2 times more effective than betaseron in protecting
30 Hep2 cells against a viral challenge. Antiviral activity is again determined according to the modified method of Armstrong (1971). Actinomycin D was

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omitted in the antiviral determination in HepG2 cells.

The oligosaccharides associated with the interferon β of the invention may also characterise the interferon β . The interferon β carries oligosaccharides which can be characterised by one or more of the following features:

- 5 1. Neutral (no acidic substituents): 5 to 15%, preferably about 10% or lower.
Acidic : 95 to 85%, preferably about 90% or higher.
2. The total desialylated oligosaccharide pool is heterogeneous with at least six distinct structural components present in the pool.
3. Matrix-Assisted Laser Desorption Ionisation - Time of Flight (MALDI-TOF)
10 mass spectrometry and high resolution gel permeation chromatography data are summarised as follows:

Mass detected	Composition	Calculated Mass	gu equivalent
1786.2	5Hex, 4HexNAc, 1 2AB, Na	1782	11.1
1929.9	5Hex, 1dHex, 4HexNAc, 1 2AB, Na	1928	12.2
2295.5	6Hex, 1dHex, 5HexNAc 1 2AB, Na	2293	14.5
2660.1	7Hex, 1dHex, 6HexNAc 1 2AB, Na	2658	17.6
3019.1	8Hex, 1dHex, 7HexNAc, 1 2AB, Na	3023	20.7

20

The carbohydrate moiety of the human interferon β of WO 96/30531 consists of bi-, tri- and tetra-antennary complex type N-linked oligosaccharides. These oligosaccharides contain repeating lactosamine(s). About 20 to 50%, for example 20
25 to 30%, 30 to 40% or 35 to 50%, of the oligosaccharides are bi-antennary

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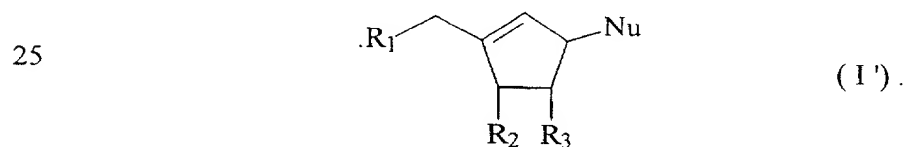
oligosaccharides. About 30 to 65%, for example from 40 to 60% or 50 to 60%, of the oligosaccharides are tri-antennary oligosaccharides. About 2 to 15%, for example from 2 to 8%, 4 to 10% or 5 to 15%, of the oligosaccharides are tetra-antennary oligosaccharides. Percentages are calculated by weight of total analysable oligosaccharide content.

Compounds (b)

The compounds (b) are capable of inhibiting particular enzymes. Amongst the 5-membered cyclic nucleosides of formula (I), some of those in which $\sim X \sim$ is -O-, such as pyrazofurin and 6-azauridine, are inhibitors of orotidylate decarboxylase whilst tiazofurin and selenofurin are inhibitors of inositol monophosphate dehydrogenase (IMPH). Compounds of formula (I) in which $\sim X \sim$ is =CH- are typically inhibitors of cytosine triphosphate (CTP) synthetase and S-adenosylhomocysteine hydrolase.

The mycophenolic acid compounds of formula (II) and the imidazole derivatives of formula (III) are typically inhibitors of inosine monophosphate (IMP) dehydrogenase. The aminoadamantanes of formula (IV) inhibit the uncoating of influenza viruses. The 2,4-diaminopyrimidines of formula (V) and the quinazoline derivatives of formula (V') are inhibitors of dihydrofolate reductase.

In one embodiment the 5-membered cyclic nucleosides of formula (I) are cyclopentenyl carbocyclic nucleosides in which $\sim X \sim$ is =CH-. These have the following structure (I'):

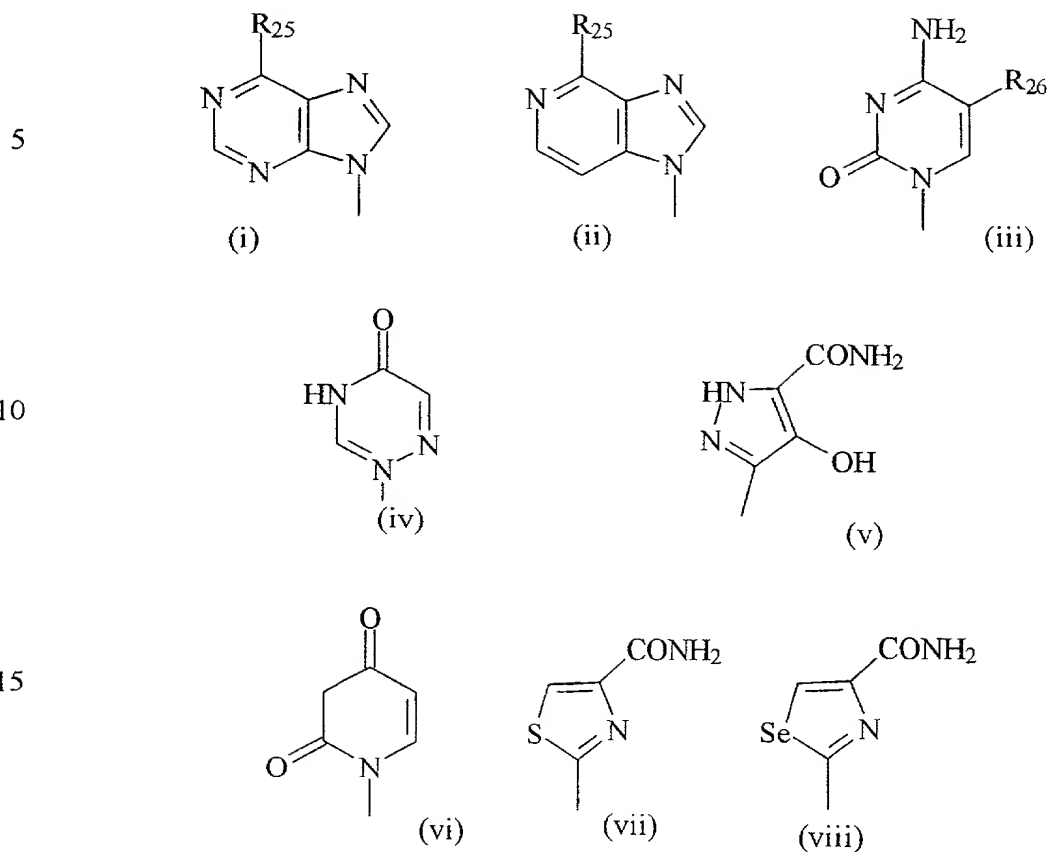


wherein R_1 , R_2 , R_3 and Nu are as defined above for formula (I).

30 Preferred 5-membered cyclic nucleosides of formula (I) and cyclopentenyl carbocyclic nucleosides of formula (I') are compounds in which Nu denotes one of

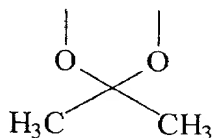
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the following groups (i) to (viii):



wherein R_{25} is Cl or NH_2 and R_{26} is H, CH_3 , CF_3 , F, Cl, Br or I.

When one or more of R_1 , R_2 and R_3 is O-acyl in formula (I) or (I'), the acyl group is preferably a group having the formula $R_{27}-CO-$ in which R_{27} is C_1-C_6 alkyl such as C_1-C_4 alkyl, for example methyl or ethyl. The O-aryl group is generally a O-
 25 (C_6-C_{10}) aryl group such as O-phenyl or O-benzyl. R_2 and R_3 may together denote a ketal group such as



The 5-membered cyclic nucleosides of formula (I) are known compounds and

may be synthesised by published procedures or by analogy with published procedures. For instance the synthesis of carbocyclic adenosine [(±)-aristeromycin] is described by Shealy *et al* in J. Am Chem. Soc. 1966, 88, 3885 and in J. Am. Chem. Soc. 1969, 91, 3075. The enantioselective synthesis of (-) aristeromycin and (-)-
 5 neplanocin A is described by Arita *et al* in J. Am. Chem. Soc. (1983), 105 (12), 4049-4055.

The synthesis of pyrazofurin is described by Petrie *et al* in J. Med. Chem 1986, 29, 268-278. The synthesis of 6-azauridine is described by Cristescu in Rev. Roum. Chim (1968), 13(3), 365-9. The synthesis of tiazofurin (2-β-D-
 10 ribofuranosylthiazole-4-carboxamide) and selenofurin (2-β-D-ribofuranosylselenazole-4-carboxamide) is described by Hennen *et al* in J. Org. Chem (1985) 50(10), 1741-1746. The synthesis of suitable cyclopentenyl carbocyclic nucleosides of formula (I') is described in US-A-4975434, the contents of which are incorporated herein by reference. Specific nucleosides are listed in that patent.

15 The substitution patterns of preferred compounds of formula (I) are shown in Table 1 below. A particularly preferred compound is cyclopentenyl cytosine (CPE-C).

Table 1: Substitution patterns within formula (I)

20

~ X ~	R ₁	R ₂	R ₃	formula of Nu	Compound
=CH -	OH	OH	OH	(ii) wherein R ₂₅ is NH ₂	3-deazaneplanocin
=CH-	OH	OH	OH	(i) wherein R ₂₅ is NH ₂	neplanocin A
-O-	OH	OH	OH	(vi)	3-deazauridine
-O-	OH	OH	OH	(iv)	6-azauridine (NSC 32074)

25

-CH ₂ -	OH	OH	OH	(i) wherein R ₂₅ is NH ₂	aristeromycin (NSC 103526)
-O-	OH	OH	OH	(v)	pyrazofurin (NSC 143095)
=CH-	OH	OH	OH	(iii) wherein R ₂₆ is H	cyclopentenylcytosine (CPE-C)
-O-	OH	OH	OH	(vii)	tiazofurin (NSC 286193)
-O-	OH	OH	OH	(viii)	selenofurin (NSC 340847)

As used herein the term "metabolite" refers to a compound for which a compound of formula (I) is a prodrug. For instance, tiazofurin and selenofurin are prodrugs for thiazolamide adenine dinucleotide (TAD) and selenazolamide adenine dinucleotide (SAD), respectively. In each case the metabolite, rather than the prodrug, is the active moiety. Examples of derivatives (or analogues) of these particular metabolites, which are also encompassed within the present invention, include beta-methylene TAD and beta-methylene SAD. These compounds are published in the literature.

The mycophenolic acid compounds of formula (II) include compounds in which R₄ is hydroxy or NH₂. When one or more of R₅, R₆, R₇ and R₈ is a C₁-C₆ alkyl group, preferably it is a C₁-C₄ alkyl group such as methyl or ethyl. The five- or six-membered saturated or unsaturated heterocyclic ring generally contains one, two or three N-atoms and optionally an O- and/or S-atom. Suitable such rings include pyridino, piperidino, pyrrolo, pyrrolidono and morpholino rings. A N-morpholino ring may thus be present.

Mycophenolic acid compounds for use in the invention include mycophenolic acid, mycophenolate mofetil which is the morpholinoethyl ester of mycophenolic acid, and the individual mycophenolic acid derivatives described in US-A-5380879. The contents of US-A-5380879 are incorporated herein by reference.

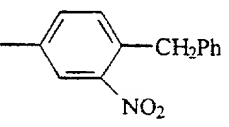
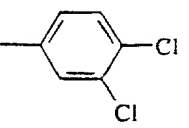
Suitable imidazole derivatives of formula (III) are compounds wherein R_{10} is hydrogen, C_1 - C_4 alkyl such as methyl or ethyl, hydroxy(C_1 - C_4 alkyl) in which the alkyl group may be methyl or ethyl, or phenyl. R_{12} may be hydrogen or any appropriate protecting group such as an acyl, alkyloxymethyl, substituted ethyl, aralkyl, pyranyl, silyl, acetal or ketal group. Typically, R_{11} and/or R_{13} is H or OH.

Imidazole derivatives of formula (III) are described in US-A-5126361, the contents of which are incorporated herein by reference. A particularly preferred imidazole derivative is 5-ethynyl-1- β -D-ribofuranosyl-imidazole-4-carboxamide (EICAR). EICAR is a compound of formula (III) in which A is $CONH_2$, R_9 is D-ribose and R_{10} is hydrogen.

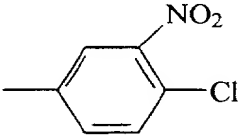
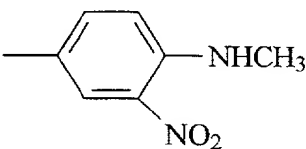
Aminoadamantanes of formula (IV) are described in US-A-5599998, the contents of which are incorporated herein by reference. In formula (IV), R_{18} and R_{19} may each independently denote hydrogen, C_1 - C_4 alkyl such as methyl or ethyl, phenyl or benzyl. Suitable compounds include 1-aminoadamantane ("amantidine"), α -methyl-1-adamantylmethylamine ("rimantadine") and 1-amino-3,5-dimethyladamantane ("momantine").

The synthesis of 2,4-diaminopyrimidines of formula (V) is described by D. J. Brown in the chapter "Pyrimidines and their Benzo Derivatives" in Comprehensive Heterocyclic Chemistry, Vol. 3, part 2B, A. Boulton and A. McKillop (Eds), 1983, Pergamon, Oxford, page 151, the contents of which are incorporated herein by reference. The substitution patterns of preferred compounds of formula (V) are shown in Table 2 below:

Table 2 Substitution patterns within formula (V)

R_{20}	R_{21}	Compound
	$-CH_2CH_3$	NSC 382046
	$-CH_3$	NSC 7364

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	-CH ₂ CH ₃	NSC 302325
	-CH ₂ CH ₃	NSC 382034

5 The quinazoline derivatives of formula (V') may be synthesised as described by Hynes *et al* in J.Med. Chem., 1977, Vol 20, No. 4, 588-591 or by analogy with the methods described there. A preferred quinazoline derivative of formula (V') is the compound wherein R₂₂ is C₂H₅, R₂₃ and R₂₄ are both H and n is 1. This is known as NSC 184692.

10 Pharmaceutically acceptable salts, particularly pharmaceutically acceptable acid addition salts, of any of the compounds of formula (I) to (IV) may be used. Salts with physiologically acceptable inorganic or organic acids may be employed, for example the hydrochloride salt.

15 Therapeutic uses

The interferons and compounds (b) are used together to treat flavivirus and rhabdovirus infections, particularly in humans. The infection may be acute or chronic. The flavivirus may be yellow fever virus, kunjin virus, dengue virus, hepatitis C virus, or an encephalitis virus such as St. Louis encephalitis virus,

20 Japanese encephalitis virus, Murray valley encephalitis virus and tick-borne

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encephalitis virus. The rhabdovirus may be vesicular stomatitis virus (VSV) or rabies virus.

The interferon and at least one compound (b) are administered to a subject to be treated in sufficient amounts to produce a synergistic antiviral or synergistic antirhabdoviral effect. The condition of the subject can thus be improved. The infection may be cleared from the subject entirely. Relative to monotherapy, lower doses of the interferon and of the compound(s) (b) can be used, which results in a cost-saving and a reduction or elimination of side effects that might occur at higher doses.

Separate formulations of the interferon on the one hand and of the compound(s) (b) on the other hand will generally be given to a patient. A single formulation containing both components can be administered if the interferon and compound(s) (b) are stable in each other's presence and do not otherwise interfere with each other.

The interferon may be administered to humans in various manners such as orally, intravenously, intramuscularly, intraperitoneally, intranasally, intradermally, topically and subcutaneously. The particular mode of administration and dosage regimen will be selected by the attending physician taking into account a number of factors including the age, weight and condition of the patient, the nature of the viral infection, the compound(s) (b) with which it is being administered and the need to obtain a synergistic effect.

The pharmaceutical compositions that contain the interferon as an active principal will normally be formulated with an appropriate pharmaceutically acceptable carrier or diluent depending upon the particular mode of administration being used. For instance, parenteral formulations are usually injectable fluids that use pharmaceutically and physiologically acceptable fluids such as physiological saline, balanced salt solutions, or the like as a vehicle. Oral formulations, on the other hand, may be solids, e.g. tablets or capsules, or liquid solutions or suspensions.

The interferon will usually be formulated as a unit dosage form that contains from 10^4 to 10^9 , more usually 10^6 to 10^7 , IU per dose. Typically from 3×10^6 to 18×10^6 IU of interferon is administered per day, particularly by injection such as

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intravenously or subcutaneously. The dosage may be administered daily, for example for up to five or up to twenty weeks.

The compound(s) (b) can similarly be administered in a variety of dosage forms, for example orally such as in the form of tablets, capsules, sugar- or film-coated tablets, liquid solutions or suspensions, topically such as in the form of
5 creams, ointments or gels, or parenterally, for example intramuscularly, intravenously or subcutaneously. They may therefore be given by injection or infusion.

The mode of administration and dosage regimen of the compound(s) (b) also depends on a variety of factors including the particular compound(s) (b) concerned,
10 the age, weight and condition of the patient, the nature of the viral infection and the need to obtain a synergistic effect. Typically, however, the dosage adopted for each route of administration for humans, for example adult humans, is 0.001 to 10 mg/kg, most commonly in the range of 0.01 to 5 mg/kg, body weight. Such a dosage may be given, for example, daily. The dosage may be given orally or by bolus infusion,
15 infusion over several hours and/or repeated administration.

The interferon and the compound(s) (b) may be given simultaneously. Alternatively they may be given up to five days from each other, for example up to two days apart or up to one day apart or up to four hours apart. The relative timing of the administration of the interferon and the compound(s) (b) may be determined by
20 monitoring their respective serum levels. The interferon may be given before the compound(s) (b) or *vice versa*. Two or three compound(s) (b) may be given, for example simultaneously or spaced apart timewise as above.

A suitable treatment regiment may be illustrated with reference to CPE-C. As noted previously, two patients treated with CPE-C died in a clinical trial as a result of
25 hypotension. At dosages ≤ 2.5 mg/m²/h no hypotension was observed. Consequently, interferon $\alpha 8$ or interferon β must be used with CPE-C at dosages of CPE-C below which substantial hypotension occurs.

This may be achieved according to the invention by subcutaneous or intravenous injection of from 0.01 to 2.5 mg of CPE-C/m²/h and from 3 to 18, for
30 example 3, 6, 12 or 18, x 10⁶ IU of interferon on day 1. The CPE-C may be injected simultaneously with the interferon. Alternatively, the interferon may be injected up

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to 4 hours later, for example from 1 to 4 hours later. On days 2 and 3, 3 to 18×10^6 IU of the interferon may be given to the patient. On day 4, the combination treatment of CPE-C and interferon can be repeated. This regimen may be repeated for several weeks, for example up to five or up to twenty weeks.

5

The following Examples illustrate the invention.

10 Example 1

Vero cells were grown to about 99% confluency in 96 microwells with minimum essential medium (MEM) containing 10% fetal calf serum. Growth medium was removed from the microwells and incubated with one of the following. The experiment was done in quadruplicates or duplicates:-

15

- (1) 100 μ l of interferon $\alpha 8$ containing either 6, 3, 0.6, 0.3, 0.06, or 0.03 IU of interferon (Reference to Gb 23-902-531, NIH standard, distributed by the Natl. Inst. Allergy and Infectious Diseases, NIH, USA) per ml of MEM containing 2.5 mg/ml human serum albumin.
- 20 (2) 100 μ l of interferon $\alpha 2$ containing either 6, 3, 0.6, 0.3, 0.06 or 0.03 IU of interferon (Reference to Gb-23-902-530 as well as Gb-23-902-531 standards) per ml of MEM containing 2.5 mg/ml human serum albumin.
- (3) 100 μ l of interferon β containing 60, 30, 6, 3 or 0.6 IU of interferon (Reference to Gb23-902-531 standard) per ml of MEM containing 2.5 mg/ml human
- 25 serum albumin.

After the addition of interferon to the Vero cells in the microwell, 100 μ l of a viral challenge consisting of 100 TCID₅₀ yellow fever virus, kunjin virus or dengue virus was added immediately to each of the microwells. Different concentrations of

30 test compound were included in the viral challenge as well. In the case where no test compound was used (i.e. the viral control), only 100 μ l of the viral challenge was

added to the wells in 100 μ l of MEM containing 2.5 mg/ml human serum albumin.

The test compounds used were cyclopentenyl cytosine (CPE-C) from the National Cancer Institute, USA; mycophenolic acid from Sigma Chemicals; 5-ethynyl-1- β -D-ribofuranosylimidazole-4-carboxamide (EICAR); and amantadine hydrochloride.

In the control cells treated with test compound alone, 100 μ l of MEM containing 2.5 mg/ml human serum albumin instead of interferon was added to the cells followed by an addition of another 100 μ l of MEM/human serum albumin (2.5 mg/ml) containing test compound. In the case of CPE-C, the concentrations of CPE-C in MEM were 2 μ M, 0.22 μ M and 0.022 μ M. The subsequent concentrations of CPE-C in the wells were therefore 1 μ M, 0.11 μ M and 0.011 μ M.

The cells were examined for virus-induced cythopathic effects on day 5, day 8 and day 9 respectively for the antiviral activities of interferon or of test compound(s) or of interferon and test compound(s) protecting against a challenge virus of yellow fever, kunjin or dengue virus. The results of the enhancement of the antiviral effect of interferon by CPE-C is given in Table 3.

Table 3

Human interferon	μ M CPE-C	Fold enhancement of antiviral activity interferon
α 8	1	30
α 8	0.11	10
α 8	0.01	0
None	1*	0
None	0.11**	0
None	0.011#	0
α 2	1	10
α 2	0.11	5
α 2	0.01	0
None	1*	0
None	0.11**	0
None	0.011#	0

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5	β	1	10
	β	0.11	5
	β	0.01	0
	None	1*	0
	None	0.11**	0
	None	0.011#	0

* 75-90% of the Vero cells were protected against a yellow fever virus challenge of 100 TCID₅₀

10 ** 40-50% of the Vero cells were protected against a yellow fever virus challenge of 100 TCID₅₀.

none of the Vero cells were protected against a yellow fever virus challenge of 100 TCID₅₀ at this concentration of CPE-C.

15 Similar results in enhancement of the antiviral activity of interferon were observed when a viral challenge of 100 TCID₅₀ of kunjin virus (0.11 μ M of CPE-C enhanced interferon α 8, interferon α 2 and interferon β by 10-, 5- and 5-fold respectively) or dengue virus (0.11 μ M of CPE-C enhanced interferon α 8, interferon α 2 and interferon β by 12-, 5- and 6-fold respectively) was used in place of yellow
20 fever virus.

Similar experiments were repeated with mycophenolic acid, amantadine hydrochloride and EICAR. The concentration required to enhance the anti-viral activity of human interferon α 8 is summarized in Table 4.

25

30

Table 4

Human interferon	μ M of test compounds #	Fold enhancement of antiviral activity
α 8	0.1 CPE-C(C)	10
α 8	0.1 mycophenolic acid	3
α 8	(MA)	3
α 8	1.0 EICAR (E)	2
α 8	1.0 amantadine (A)	50

Indicates the concentration of test compound alone to protect Vero cells against a viral challenge by approximately 50%. In the case of mycophenolic acid, 2% fetal calf serum was used in place of human serum albumin.

15 Example 2

Monkey (Vero) or human (HuH7) cells were grown on 96 microwells as described in Example 1. When the cells were grown to 90-100% confluency with growth medium (MEM or DMEM) containing 5 or 10% fetal calf serum, the growth medium was removed from the microwells and the cells re-incubated with one of the following. The experiment was done in quadruplicates or duplicates:-

100 μ l of human interferon α 8, α 2 or β interferon serially diluted from 30, 10, 3.3, 1.0, 0.33, 0.1, 0.033, 0.01, etc (Reference to Gb 23-902-531, NIH standard, distributed by the Natl. Inst. Allergy and Infectious Diseases, NIH, USA). In certain experiments using human cells, a serial 2-fold dilution of the interferon was used instead of the 30, 10, 3.3, 1.0, etc, dilution steps.

After adding the different concentrations of interferon to the cells in the microwells, 100 μ l of a viral challenge (yellow fever, dengue, kunjin virus or VSV) was immediately added to the microwells of cells previously treated with interferon and such that the viral challenge has a final TCID₅₀ of 100. Different concentrations of test compounds were added in the viral challenge. In the case where no test

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compound was used (viral control) 100 µl viral challenge was added to the wells in 100 µl of MEM containing 2.5 mg/ml human serum albumin. The interferon control cells were challenged with virus without test compound. The test compound controls were challenged with virus but no interferon. The test compounds used were

- 5 cyclopentenyl cytosine (CPE-C) from the National Cancer Institute, USA;
- mycophenolic acid from Sigma Aldrich Inc.; 5-ethynyl-1-β-D-ribofuranosylimidazole-4-carboxamide (EICAR); amantadine hydrochloride;
- neplanocin A (provided by NCI, U.S.A.); 3-deazaneplanocin A (provided by NCI, USA); 3-deazauridine (Aldrich Chemical Co Inc.); NSC 382046, NSC 143095 and
- 10 Artisteromycin (Sigma Aldrich Inc).

The cells were examined for virus-induced cytopathic effects on days 1, 2, 3, 4, 5, 6, 7 and 8, depending on the virus used for the antiviral activities of interferon or of test compound(s) or of interferon and test compound(s) protecting against a challenge virus of either yellow fever, dengue, kunjin virus or VSV. The results of the enhancement of the antiviral effect of the interferon used by each of the above test compounds are shown in the following Tables 5 to 22.

In the tables the IC₅₀ values represent the concentration of each agent required to give a 50% inhibition of cell death following viral challenge. Where an IC₅₀ value is shown as zero for one agent, that agent was not present. In those cases the IC₅₀ given for the other agent is the ED₅₀ of the latter alone.

CI in the tables represents the combination index. This is a parameter which reflects the presence or absence of synergism between two pharmacologically active agents. The calculation of the combination index is described by T.M. Brennan *et al* in Antiviral Research 1995, 173-187. The equation as used in the present experiments was therefore

$$CI = \left(\frac{\text{concentration of drug (b)}}{IC_{50} \text{ of drug (b) alone}} \right) + \left(\frac{\text{concentration of IFN}}{IC_{50} \text{ of IFN alone}} \right)$$

30

If the CI is equal to 1 the two agents have a mutually additive effect. If the CI

is less than 1 they have a synergistic effect. If the CI is greater than 1 they have a mutually antagonistic effect. (M.C. Berenbaum in Pharmacol. Rev. 41, 93-141 (1989)).

Table 5: Mycophenolic acid (MPA) and IFN in Vero cells

Virus	IFN α 2 IC ₅₀ (IU/ml)	MPA IC ₅₀ (μ M)	CI	IFN α 8 IC ₅₀ (IU/ml)	MPA IC ₅₀ (μ M)	CI	IFN β IC ₅₀ (IU/ml)	MPA IC ₅₀ (μ M)	CI
Yellow fever	0.153	0	-	0.127	0	-	4.688	0	-
	0.076	0.275	0.695	0.076	0.184	0.731	1.376	1.388	0.96
	0.076	0.413	0.794	0.048	0.275	0.576	0	2.081	-
	0.048	0.619	0.757	0.048	0.413	0.675			
	0.048	0.928	0.980	0.048	0.619	0.822			
	0	1.388	-	0	1.388				
Dengue virus	0.489	0	-	0.489	0	-	4.688	0	-
	0.244	0.275	0.702	0.244	0.275	0.702	1.465	0.413	0.61
	0.153	0.413	0.610	0.076	0.413	0.453	1.465	0.619	0.758
	0.015	0.619	0.474	0.048	0.619	0.542	0.458	0.928	0.764
	0.015	0.928	0.697	0.016	0.928	0.699	0	1.388	-
	0	1.388	-	0	1.388	-			

Kunjin virus	0.092	0	-	0.092	0	-	0.916	0	-
	0.014	0.413	0.598	0.009	0.275	0.395	0.286	0.413	0.610
	0.009	0.619	0.767	0.009	0.413	0.544	0.090	0.619	0.542
	0	0.928	-	0.009	0.619	0.767	0.286	0.928	0.979
				0	0.928	-	0	1.388	-

Table 6: CPE-C and IFN in Vero cells

Virus	IFN α 2 IC ₅₀ (IU/ml)	CPE-C IC ₅₀ (μ M)	CI	IFN α 8 IC ₅₀ (IU/ml)	CPE-C IC ₅₀ (μ M)	CI	IFN β IC ₅₀ (IU/ml)	CPE-C IC ₅₀ (μ M)	CI
Yellow Fever	0.489	0	-	0.489	0	-	4.688	0	-
	0.153	0.017	0.513	0.153	0.017	0.513	1.465	0.025	0.513
	0.048	0.025	0.398	0.153	0.025	0.613	1.465	0.038	0.613
	0.048	0.038	0.548	0.048	0.038	0.548	0.458	0.056	0.531
	0.024	0.056	0.699	0.048	0.056	0.748	0.045	0.085	0.676
	0	0.085	-	0	0.085	-		0.127	-

Dengue virus	4.688	0	-	1.465	0	-	30	0	-
	0.229	0.142	0.144	0.458	0.017	0.345	2.930	0.285	0.231
	0.045	0.199	0.141	0.143	0.033	0.162	2.930	0.398	0.284
	0.045	0.279	0.197	0.045	0.067	0.159	0.916	0.558	0.291
	0.045	0.390	0.270	0.045	0.134	0.279	0.916	0.781	0.395
	0.045	0.547	0.374	0.045	0.268	0.535	0.286	1.093	0.519
	0.045	0.765	0.519	0	0.536	-	0.286	1.530	0.723
	0.045	1.071	0.724				0	2.142	-
	0	1.500	-						
Kunjin virus	0.293	0	-	0.293	0	-	0.916	0	-
	0.092	0.025	0.450	0.092	0.025	0.404	0.286	0.025	0.402
	0.092	0.038	0.519	0.029	0.038	0.233	0.286	0.038	0.447
	0.029	0.056	0.394	0.029	0.056	0.293	0.090	0.056	0.292
	0.009	0.085	0.485	0.029	0.085	0.397	0.045	0.085	0.348
	0.009	0.127	0.713	0.029	0.127	0.547	0.090	0.127	0.546
	0	0.191	-	0.029	0.191	0.756	0	0.280	-
				0	0.286	-			

Table 7: 3-deazauridine (3-DAU) and IFN in Vero cells

Virus	IFN α 2 IC ₅₀ (IU/ml)	3-DAU IC ₅₀ (μ M)	CI	IFN α 8 IC ₅₀ (IU/ml)	3-DAU IC ₅₀ (μ M)	CI	IFN β IC ₅₀ (IU/ml)	3-DAU IC ₅₀ (μ M)	CI
Yellow Fever	0.489	0	-	0.245	0	-	1.465	0	-
	0.153	4.115	0.513	0.048	12.346	0.624	0.458	20.996	0.823
	0.077	12.346	0.757	0.015	20.576	0.776	0.143	29.394	0.812
	0	20.576	-	0	28.807	-	0	41.152	-

Table 8: 3-deazaneplanocin A (3-DAN) and IFN in Vero cells

Virus	IFN α 2 IC ₅₀ (IU/ml)	3-DAN IC ₅₀ (μ M)	CI	IFN α 8 IC ₅₀ (IU/ml)	3-DAN IC ₅₀ (μ M)	CI	IFN β IC ₅₀ (IU/ml)	3-DAN IC ₅₀ (μ M)	CI
Yellow fever	0.488	0	-	0.488	0	-	1.465	0	-
	0.015	0.725	0.395	0.076	0.725	0.416	0.143	0.725	0.462
	0.015	1.015	0.541	0.048	1.015	0.463	0.143	1.015	0.608
	0.015	1.420	0.745	0.015	1.420	0.541	0.143	1.420	0.812
	0	1.989	-	0	1.989	-	0	1.989	-
Dengue virus	1.465	0	-	1.465	0	-	9.375	0	-
	0.458	0.725	0.677	0.143	0.725	0.462	0.915	1.015	0.608
	0.143	1.015	0.608	0.045	1.015	0.541	0.089	1.420	0.724
	0.045	1.420	0.745	0.045	1.420	0.745	0	1.989	-
	0	1.989	-	0	1.989	-	0	1.989	-

Table 9: 6-azauridine (6-AU) and IFN in Vero cells

Virus	IFN α 2 IC ₅₀ (IU/ml)	6-AU IC ₅₀ (μ M)	CI	IFN α 8 IC ₅₀ (IU/ml)	6-AU IC ₅₀ (μ M)	CI	IFN β IC ₅₀ (IU/ml)	6-AU IC ₅₀ (μ M)	CI
Yellow fever	0.153	0	-	0.321	0	-	2.271	0	-
	0.048	1.224	0.811	0.153	0.816	0.762	1.465	0.816	0.931
	0.015	1.633	0.765	0.048	1.224	0.578	0.458	1.224	0.630
	0.015	2.041	0.932	0.048	1.633	0.721	0.458	1.633	0.773
	0	2.449	-	0.015	2.041	0.761	0.143	2.041	0.777
				0.048	2.449	1.007	0.458	2.449	1.059
				0	2.857	-	0	2.857	-

Table 10: NSC 382046 and IFN in Vero cells against Dengue virus

IFN α 2 IC ₅₀ (IU/ml)	NSC 382046 IC ₅₀ (μ M)	CI
4.688	0	-
1.465	0.095	0.758
0.045	0.141	0.672
0	0.212	-

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Table 11: NSC 7364 and IFN in Vero cells against Dengue virus

IFN α 2 IC ₅₀ (IU/ml)	NSC 7364 IC ₅₀ (μ M)	CI	IFN α 8 IC ₅₀ (IU/ml)	NSC 7364 IC ₅₀ (μ M)	CI
1 465	0	-	4.688	0	-
0.733	0.186	0.834	1.465	0.372	0.813
0 458	0.372	0.979	0	0.743	-
0	0.558	-			

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Table 12: NSC 143095 and IFN in Vero cells against yellow fever virus

IFN α 2 IC ₅₀ (IU/ml)	NSC 143095 IC ₅₀ (μ M)	CI	IFN α 8 IC ₅₀ (IU/ml)	NSC 143095 IC ₅₀ (μ M)	CI
0.458	0	-	0.153	0	-
0.143	0.848	0.756	0.048	0.386	0.813
0.045	1.272	0.763	0	0.772	-
0	1.907	-			

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IFN β IC ₅₀ (IU/ml)	NSC 143095 IC ₅₀ (μ M)	CI
2.930	0	-
0.287	1.272	0.764
0	1.907	-

Table 13: Mycophenolic acid (MPA) and IFN α 8 in human cells against VSV and yellow fever virus

Virus	Cell type	IFN α 8 IC ₅₀ (IU/ml)	MPA IC ₅₀ (μ M)	CI
VSV	MRC 5	0	4.1	-
		4.9	0	-
		0.02	3.9	0.96
		0.01	2.6	0.64
		0.01	1.7	0.43
		0.21	1.2	0.33
		0.43	0.8	0.28
		1.22	0.5	0.37
		2.18	0.3	0.53
		4.39	0.2	0.95
		4.65	0.2	0.98
	HuH7	0	1.72	-
		2.06	0	-
		0.13	0.72	0.48
		0.38	0.48	0.46
		0.77	0.32	0.56

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Yellow fever	HuH7	0	3.86	-
		7.85	0	-
		1.73	2.48	0.86
		1.94	1.65	0.68
		1.94	1.10	0.53
		1.22	0.73	0.35
		2.76	0.49	0.48
		6.99	0.33	0.97

Table 14: CPE-C and IFN in human cells against VSV and kunjin virus.

5	Cell type	Virus	IFN β IC ₅₀ (IU/ml)	CPE-C IC ₅₀ (μ M)	CI
	HuH7	VSV	0 35.7 0.81 0.81 0.81 1.08 1.94 2.59	4.18 0 1.84 1.23 0.82 0.55 0.36 0.24	- - 0.46 0.32 0.22 0.16 0.14 0.13
		Kunjin	0 2.59 0.20 0.23 0.08 0.81 1.83	0.37 0 0.25 0.17 0.11 0.07 0.01	- - 0.75 0.54 0.33 0.51 0.84

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Cell type	Virus	IFN α 8	CPE-C	CI
		IC ₅₀ (IU/ml)	IC ₅₀ (μ M)	
MRC-5	VSV	0	2.26	-
		3.10	0	-
		0.19	2.09	0.98
		0.61	1.39	0.81
		1.22	0.93	0.80
		2.45	0.41	0.97
		1.94	0.28	0.75
		2.18	0.18	0.79
		2.18	0.12	0.76
		2.18	0.08	0.74

Table 15: 3-deazaneplanocin A (3-DAN) and IFN in human cells against VSV

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Cell type	3-DAN	IFN IC ₅₀ (IU/ml)		CI
		IFN α 8	IFN β	
MRC 5	0.172	0		-
	0	3.10		-
	0.115	0.38		0.79
	0.076	1.09		0.80
	0.051	1.94		0.92
	0.034	2.18		0.90
	0.023	2.18		0.84
	0.015	2.45		0.88
	0.010	2.45		0.85

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HuH7	0.126		0	-
	0		19.80	-
	0.095		0.54	0.79
	0.064		0.54	0.54
	0.042		0.86	0.38
	0.028		1.22	0.29
	0.019		1.94	0.25
	0.013		2.18	0.21

Table 16: 6-azauridine (6-AU) and IFN β in human cells against VSV

5	Cell type	IFN β IC ₅₀ (IU/ml)	6-AU IC ₅₀ (μ M)	CI
	MRC 5	0	80.8	-
		2.20	0	-
		0.38	25.3	0.49
		1.09	7.8	0.59
		1.22	2.4	0.59

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Table 17: NSC 382046 and IFN β in human HuH7 cells against yellow fever and kunjin virus

Virus	IFN β	NSC 382046	CI
	IC ₅₀ (IU/ml)	IC ₅₀ (μ M)	
5 Yellow fever	0	0.350	-
	2.59	0	-
	0.81	0.192	0.86
	0.72	0.128	0.64
	0.57	0.085	0.46
	0.57	0.057	0.38
	0.57	0.038	0.33
	0.72	0.025	0.35
	0.81	0.017	0.36
	0.81	0.011	0.34
Kunjin virus	0	5.264	-
	18.74	0	-
	8.30	2.865	0.99
	11.10	1.910	0.96
	11.10	1.273	0.83
	11.10	0.849	0.75
	11.10	0.566	0.70

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Table 18: NSC 143095 and IFN β in human HuH7 cells against yellow fever virus and VSV.

Virus	IFN β	NSC 143095	CI
	IC ₅₀ (IU/ml)	IC ₅₀ (μ M)	
5 VSV	0	11.822	-
	6.21	0.00	-
	0.08	6.448	0.56
	0.08	4.299	0.38
	0.25	2.866	0.28
	0.57	1.910	0.25
	1.83	1.274	0.40
	3.68	0.849	0.66
Yellow fever	0	0.510	-
	2.06	0.00	-
	0.08	0.340	0.71
	0.25	0.227	0.57
	0.81	0.151	0.69

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Table 19: Tiazofurin and IFN β in human HuH7 cells against yellow fever virus and kunjin virus

Virus	IFN β	Tiazofurin	CI
	IC ₅₀ (IU/ml)	IC ₅₀ (μ M)	
5 Yellow fever	0	7.538	-
	0.37	0	-
	0.01	6.154	0.85
	0.05	4.103	0.68
	0.10	1.823	0.51
	0.28	0.812	0.87
Kunjin virus	0	6.923	-
	0.20	0	-
	0.01	4.615	0.73
	0.01	3.077	0.51
	0.02	2.051	0.38
	0.03	1.368	0.32
	0.04	0.912	0.33
	0.04	0.608	0.29
	0.08	0.405	0.46

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Table 20: Selenofurin and IFN β in human HuH7 cells against yellow fever virus and kunjin virus

Virus	IFN β	Selenofurin	CI
	IC ₅₀ (IU/ml)	IC ₅₀ (μ M)	
5 Yellow fever	0	0.472	-
	0.43	0	-
	0.05	0.391	0.94
	0.04	0.261	0.65
	0.07	0.173	0.53
	0.16	0.117	0.62
	0.16	0.052	0.49
Kunjun virus	0	0.717	-
	0.20	0	-
	0.01	0.554	0.84
	0.01	0.369	0.58
	0.05	0.164	0.48
	0.05	0.109	0.40
	0.08	0.073	0.51
	0.08	0.049	0.47

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Table 21: Amantadine and human IFN in human cells against VSV and kunjin virus

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Cell Type	Virus	Amantadine IC ₅₀ (μM)	IFN IC ₅₀ (IU/ml)		CI
			IFN α8	IFN β	
MRC-5	VSV	913.8	0		-
		0	0.81		-
		584.9	0.12		0.79
		390.1	0.27		0.76
		259.9	0.27		0.62
		173.0	0.38		0.66
		115.8	0.61		0.87
HuH7	Kunjin virus	115.7		0	
		0		0.13	
		77		0.01	0.76
		51.3		0.04	0.76

Table 22: Neplanocin A and human IFN in human cells against VSV and Yellow Fever Virus

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Cell Type	Virus	Neplanocin A IC ₅₀ (μM)	IFN IC ₅₀ (IU/ml)		CI
			IFN α8	IFN β	
MRC-5	VSV	2.9	0		-
		0	2.18		-
		2.2	0.04		0.80
		1.5	0.09		0.56
		1.0	0.12		0.40
		0.7	0.97		0.67
		0.4	1.22		0.71

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HuH7	Yellow Fever	9.3		0	
		0		5.86	
		5.1		0.01	0.63
		3.4		0.04	0.71
		2.2		2.06	0.59

Example 3

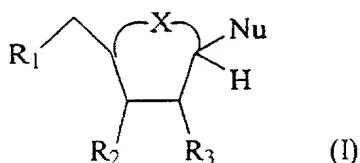
5

By following the experimental procedure described in Examples 1 and 2 the compound NSC 184692 was found to have an ED₅₀ against dengue virus of 120 pM in monkey Vero cells subjected to viral challenge by 100 TCID₅₀ dengue virus. It was found that 100 pM of the compound enhanced the anti-viral effect of human

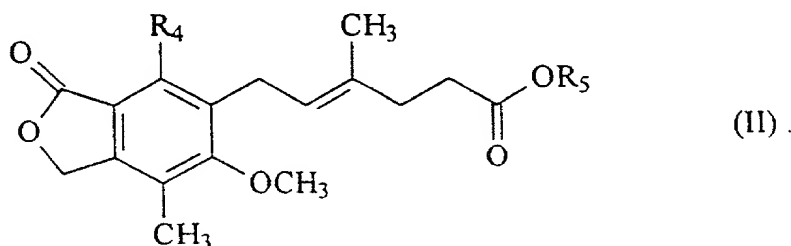
10 IFN β 10-fold.

CLAIMS

1. Use, in the manufacture of a medicament for the treatment of a
 5 flavivirus or rhabdovirus infection, of:
 (a) an interferon, and
 (b) at least one compound selected from the group consisting of:
 - 5-membered cyclic nucleosides having the formula (I):



- 15 wherein $\sim X \sim$ is $=CH-$, $-CH_2-$ or $-O-$, Nu is selected from the group consisting of purines, pyrimidines and five- or six-membered aglycones, R_2 and R_3 are independently selected from the group consisting of H, OH, O-acyl, O-aryl and O-silyl, and R_1 is as defined for R_2 and R_3 or is O-phosphate, and
 20 pharmaceutically acceptable metabolites, metabolite derivatives and salts thereof;
 - mycophenolic acid compounds having the formula (II)



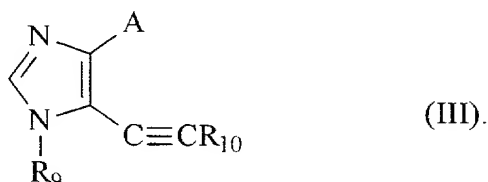
- 30 wherein R_4 is $-OR_6$ or $-N(R_7)R_8$ in which R_6 , R_7 and R_8 are independently selected from the group consisting of hydrogen and C_1-C_6 alkyl, and R_5 is selected from the group consisting of hydrogen, phenyl and C_1-C_6 alkyl unsubstituted or substituted by a five- or six-membered saturated or

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unsaturated heterocyclic ring, and pharmaceutically acceptable salts thereof,

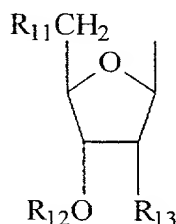
- imidazole derivatives represented by formula (III):

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10

wherein R_9 is a hydrogen atom or

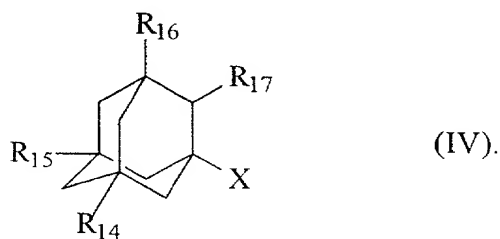


15

wherein R_{10} is a hydrogen atom, C_1 - C_6 alkyl, hydroxy(C_1 - C_6 alkyl) or phenyl, R_{11} and R_{13} are independently selected from hydrogen and OR_{12} and R_{12} is a hydrogen atom or a hydroxy protecting group and A is $CONH_2$ or CN, and pharmaceutically acceptable salts thereof;

20 -

aminoadamantanes having the formula (IV):



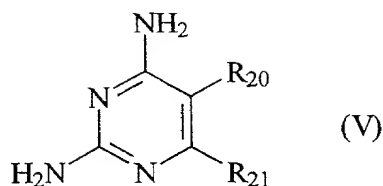
25

wherein each of R_{14} , R_{15} , R_{16} and R_{17} is independently selected from the group consisting of H, F and CH_3 and X is $N(R_{18})_2$, $CH_2CH_2N(R_{18})_2$ or $C(R_{19})_2N(R_{18})_2$ wherein each R_{18} and R_{19} is H, (C_1 - C_6) alkyl, (C_6 - C_{10}) aryl and (C_7 - C_{18}) aralkyl; and

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- 2,4-diaminopyrimidines having the formula (V):

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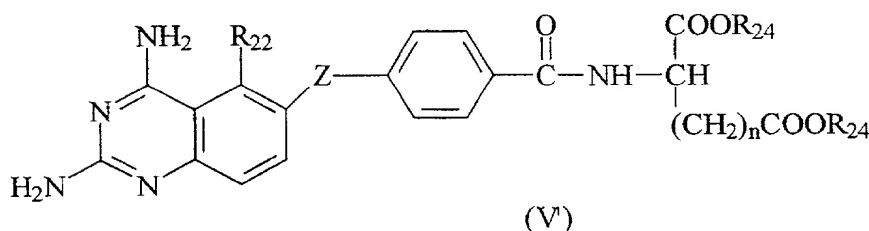


5

wherein R₂₀

is phenyl substituted by one or more substituents selected from the group consisting of benzyl, NO₂, (C₁-C₆) alkylamino and halogen and R₂₁ is H or C₁-C₆ alkyl; or R₂₀ and R₂₁ form, together with the 2,4-diaminopyrimidine ring to which they are attached, a quinazoline derivative of formula (V'):

10



(V')

wherein Z is -CH₂NR₂₃- or -NR₂₃CH₂-; R₂₂, R₂₃ and R₂₄ are each, independently, H or C₁-C₆ alkyl; and n is 1 or 2, and pharmaceutically acceptable salts thereof.

2. Use of an interferon in the manufacture of a medicament for use with at least one compound (b) as defined in claim 1 in the treatment of a flavivirus or rhabdovirus infection.

3. Use of at least one compound (b) as defined in claim 1 in the manufacture of a medicament for use with an interferon in the treatment of a flavivirus or rhabdovirus infection.

20 4. Use according to any one of claims 1 to 3, wherein the flavivirus is selected from yellow fever virus, kunjin virus, dengue virus, hepatitis C virus, St. Louis encephalitis virus, Japanese encephalitis virus, Murray valley encephalitis virus and tick-borne encephalitis virus.

5. Use according to any one of claims 1 to 3 wherein the rhabdovirus is
25 selected from vesicular stomatitis virus (VSV) and rabies virus.

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6. Use according to any one of claims 1 to 3 wherein the interferon (a) is a human interferon.

7. Use according to any one of claims 1 to 3 wherein the interferon is selected from interferon $\alpha 2$, interferon $\alpha 8$ and interferon β .

5 8. Use according to claim 7, wherein the interferon is human interferon $\alpha 8$ having a specific activity of from 0.6×10^9 to 1.5×10^9 IU per mg protein.

9. Use according to claim 7, wherein the interferon is human interferon β having a specific activity of from 4×10^8 to 8×10^8 per mg protein.

10 10. Use according to any one of the preceding claims wherein the compound (b) is at least one compound selected from cyclopentenyl cytosine, mycophenolic acid, 5-ethynyl-1- β -D-ribofuranosylimidazole-4-carboxamide, amantadine hydrochloride, 3-deazaneplanocin, neplanocin A, 3-deazauridine, 6-azauridine, aristeromycin, pyrazofurin, tiazafurin, selenofurin, NSC 382046, NSC 7364, NSC 302325, NSC 184692D and NSC 382034.

15 11. Products containing an interferon and at least one compound (b) as defined in claim 1 as a combined preparation for simultaneous, separate or sequential use in treating a flavivirus or rhabdovirus infection.

12. Use, in the manufacture of a medicament for the treatment of a flavivirus or rhabdovirus infection, of an interferon $\alpha 8$ having a specific activity of
20 from 0.6×10^9 to 1.5×10^9 IU per mg protein.

13. Use according to claim 12, wherein the flavivirus is selected from yellow fever virus, kunjin virus, dengue virus, hepatitis C virus, St. Louis encephalitis virus, Japanese encephalitis virus, Murray valley encephalitis virus and tick-borne encephalitis virus.

25 14. Use according to claim 12, wherein the rhabdovirus is VSV.

15. Use according to claim 12, wherein the interferon $\alpha 8$ is human interferon $\alpha 8$.

16. Interferon $\alpha 8$ having a specific activity of from 0.6×10^9 to 1.5×10^9 IU per mg of protein for use in a method of treatment of the human or animal body by
30 therapy.

17. Interferon $\alpha 8$ according to claim 16 for use in the treatment of a

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flavivirus or rhabdovirus infection.

18. Use of interferon $\alpha 8$ having a specific activity of from 0.6×10^9 to 1.5×10^9 IU per mg of protein in the manufacture of a medicament for use in the treatment of a flavivirus or rhabdovirus infection.

5 19. An anti-flavivirus or anti-rhabdovirus agent comprising interferon $\alpha 8$ having a specific activity of from 0.6×10^9 to 1.5×10^9 IU per mg of protein.

20. A method of treating a host having a flavivirus or rhabdovirus infection, which method comprises the step of administering to the host, in respective amounts which produce a synergistic antiviral or antirhabdoviral effect, an

10 interferon and at least one compound (b) as defined in claim 1.

21. An agent for use in the treatment of a flavivirus or rhabdovirus infection, which comprises an interferon and at least one compound (b) as defined in claim 1.

09/914184

**RULE 63 (37 C.F.R. § 1.63)
DECLARATION AND POWER OF ATTORNEY
FOR PATENT APPLICATION
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

As below named inventor(s), I/we hereby declare that

This declaration is of the following type:

- ☐ original ☐ design ☐ supplemental
☒ national stage of PCT
☐ divisional ☐ continuation ☐ continuation-in-part

My/our residence, post office address and citizenship are as stated below next to my/our name.

I/we believe I/we am/are the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

COMPOUNDS FOR TREATMENT OF VIRAL-MEDIATED DISEASES

the specification of which (check one)

- ☐ is attached hereto
☐ was filed on _____
in the United States Patent and Trademark Office as Application Serial No. _____
and was amended on _____ (if applicable)
☐ was described and claimed in PCT International Application No. PCT/US00/04699
filed on 25 Feb 2000
and as amended under PCT Article 19 on _____ (if any)

I/we hereby state that I/we have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I/we acknowledge the duty to disclose information which is material to patent ability as defined in 37 C.F.R. § 1.56.

I/we hereby claim foreign priority benefits under 35 U.S.C §119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate or under § 365(a) of any PCT International Application(s) which designated at least one country other than the United States of America, listed below and have also identified below any foreign application for patent or inventor's certificate or PCT International Application having a filing date before that of the application on which priority is claimed:

COMBINED DECLARATION AND POWER OF ATTORNEY**PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. §119**

Application No.	Country	Filing Date	Priority Claimed	
			Yes	No
60/121,931	US	26 Feb 1999	X	
60/181,068	US	8 Feb 2000	X	
PCT/US00/04699		25 Feb 2000		

I/we hereby claim the benefit under 35 U.S.C. § 119(e) of any United States Provisional Application(s) listed below:

UNITED STATES PROVISIONAL APPLICATION(S)

Application No.	Filing Date

I/we hereby claim the benefit under 35 U.S.C. § 120 of any United States Application(s) or § 365(c) of any PCT International Application(s) designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International Application in the manner provided by the first paragraph of 35 U.S.C. § 112, I/we acknowledge the duty to disclose information which is material to patent ability as defined in 37 C.F.R. § 1.56 which became available between the filing date of the prior application and the national PCT international filing date of this application.

PRIOR UNITED STATES/PCT INTERNATIONAL APPLICATION(S)

Application No.	Filing Date	Status (patented, pending/abandoned)
PCT/US00/04699	25 Feb 2000	

And I hereby appoint **Nixon & Vanderhye P.C., 1100 North Glebe Road, 8th Floor, Arlington, Virginia 22201-4714, telephone number (703) 816-400 (to whom all communications are to be directed)**, and the following attorneys thereof (of the same address) individually and collectively my attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith and with the resulting patent: Arthur R. Crawford, 25327; Larry S. Nixon, 25640; Robert A. Vanderhye, 27076; James T. Hosmer, 30184; Robert W. Faris, 31352; Richard G. Besha, 22770; Mark E. Nusbaum, 32348; Michael J. Keenan, 32106; Bryan H. Davidson, 30251; Stanley C. Spooner, 27393; Leonard C. Mitchard, 29009; Duane M. Byers, 33363; Paul J. Henon, 33626; Jeffry H. Nelson, 30481; John R. Lastova, 33149; H. Warren Burnam, Jr., 29366; Thomas E. Byrne, 32205.

I/we hereby declare that all statements made herein of my/our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C § 1001 and that such willful false statements may jeopardise the validity of the application or any patent issued thereon.

COMBINED DECLARATION AND POWER OF ATTORNEY

1W
Inventors Signature

24 September 2001
Date

Full name of first/sole inventor Yin Hwee TAN

Citizenship Singapore

Residence(City) Singapore

56X

Post Office Address 30 Medical Drive Singapore 117609 Singapore

2W
Inventors Signature

27 SEPTEMBER 2001
Date

Full name of 2nd inventor John Stanford DRISCOLL

Citizenship United States of America

Residence(City) United States of America

Post Office Address of 4 Infield Court South Rockville Maryland 20854 United States of America

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